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RECOMMENDED UNITED STATES POSITION FOR

SOLOG Study AA16

1. Authority:

The doctrinal approach generally taken by the Mine Warfare Panel in its study was that the commander's authority in employment of mine warfare must not be restricted except as necessary in coordinating the tactical or strategic plan. This is felt to be an essential requirement for the joint position. Inclosure #3 hereto is a summary of the United States position on Authority for Mine Laying. Inclosure #1 is a proposed change to Chapter 2 of FM 5-32 and Inclosure #2 a proposed change to paragraph 80, FM 101-10; both are included for guidance in specific instances.

2. Nomenclature:

Glossary of terms, Inclosure #4 hereto, is recommended as the United States position on nomenclature. Nomenclature therein is not mandatory and certain compromise may be necessary and is acceptable.

3. Density:

As a result of Mine Warfare Panel discussions, a minimum acceptable pattern density of one mine per yard of antitank mine belt trace has been established. However, the required mine field density in any situation is dependent on the terrain, the degree of fire coverage, the capabilities of the enemy, and the result desired. A detailed discussion of mine field densities is attached as Inclosure #5.

4. Patterns:

The Mine Warfare Panel feels that a simple pattern for antitank mine laying is required for use in mine fields covered by fire. This pattern has been based on four rows spaced six yards apart; the center space may be increased to 15 yards. Antipersonnel mine patterns adopted are flexible and provide for use of either trip wire or pressure-actuated antipersonnel mines. A discussion of mine patterns is attached as Inclosure #6.

Inclosures:

1. Proposed Change to Chapter 2, FM 5-32
2. Proposed Change to Par 80, FM 101-10
3. Authority for Mine Laying
4. Glossary of Terms
5. Mine Density
6. Mine Patterns

Warren W. Underwood

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Colonel, CE

Chairman, Mine Warfare Panel

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INCLOSURE A TO APPENDIX

RECOMMENDED CHANGES TO FM 5-32

Chapter 2

UNITED STATES MINE WARFARE DOCTRINE

Section I. GENERAL

14. BASIC DOCTRINE

Mine warfare is the employment of mines against an enemy and the counter-measures employed against hostile use of mines. Mine warfare is concerned primarily with the use of mine fields to provide an obstacle to enemy movement which will assist the commander in gaining the time and economy of force necessary to permit tactical or strategic flexibility. The casualty-producing effect of an individual mine is secondary even though it is essential for the successful accomplishment of the mine's primary function. The basic doctrine of US mine warfare is based on the following principles:

- e. Mine fields are active obstacles placed to improve the protection of units in defense and for the protection of the flanks and rear of units engaged in an attack or defense.
- b. The proposed location of planned mine fields must be reported to higher headquarters and immediately upon completion a location and lane report must be submitted.
- c. The location of enemy mine fields must be reported to higher headquarters as soon as discovered.
- d. All combat, supporting, and administrative troops must be adequately trained and able to install antitank and antipersonnel mines.
- e. All commanders, in formulating plans for employment of mines, will consider all aspects of the situation to include the overall scheme of maneuver, the enemy capabilities, the logistical effort required, the fire support plan, the overall barrier plan, and, if applicable the political and economic implications.

15. TRAINING

Effective application of mine warfare is dependent upon a thorough knowledge of doctrine and techniques by all commanders, staff officers, and individuals. The application of mine warfare, if not based on thorough knowledge and training, may react upon the user as markedly as upon the enemy. Intimate knowledge of mine warfare requires thorough, up-to-date, realistic training and continued retraining. Knowledge must be maintained active by a

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continuing play of mine warfare in unit exercises, maneuvers, and map exercises. It is essential that every soldier be trained not to fear mines but to respect them. He must be trained to recognize mines and to use them to provide his security. All combat troops, as well as engineers and mine specialists must be trained in the laying and breaching of mine fields, in the marking and reporting of mine fields, and in all associated techniques including allied mine clearing mines. This training is necessary for the combat arms in order that they will be capable of protecting themselves without reliance on the availability of engineers or specialists. Every commander must be held responsible for the mine discipline of his troops. It is inexcusable for any commander to direct the installation or removal of any mine field by troops who have not been fully trained in mine warfare.

Section II - CLASSIFICATION AND DEPLOYMENT OF MINE FIELDS

16. CLASSIFICATIONS

a. Functional mine fields.

Mine fields are classified functionally as follows:

- (1) Security
- (2) Defensive
- (3) Barrier
- (4) Interdictory
- (5) Deceptive

b. Definitions of functional mine fields.

The following are the definitions of functional mine fields.

(1) Security mine field. A security mine field is one which provides local protection for small units.

(2) Defensive mine field. A defensive mine field is one installed to improve the defensive positions of battalions, regiments, and divisions.

(3) Barrier mine field. A barrier mine field is installed to complete the overall defense plan of large units.

(4) Interdictory mine field. An interdictory mine field is one which hinders the enemy use of an area or route which cannot be covered by supporting ground fire.

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(5) Inceptive mine field. A deceptive mine field is a simulated mine field used in place of other type mine fields or in conjunction with them to economize on time, labor, and materiel or to camouflage lanes.

c. Definition by type. Mine fields may be further defined by the type of mine which predominates within the field. For example, an anti-tank defensive mine field is a defensive mine field which contains primarily antitank mines.

17. SECURITY MINE FIELD

a. Purpose. A security mine field provides a rapid means of improving the defense of a small unit. It affords local protection against enemy infiltration, small-unit armored or infantry attacks, and surprise.

b. Description. A security mine field may consist of one or more groups of antitank and antipersonnel mines installed by small units in front of or around their defensive position and across likely avenues of enemy approach into the position. All mines or groups of mines are covered by small-arms and direct-fire weapons.

c. Authority to install. All unit commanders are responsible for the local security of their units. A security mine field is one of the means available to a unit commander for insuring local security and preventing surprise by the enemy. Commanders of all units, down to company level, have authority to install security mine fields for local security, unless such authority is reserved or revoked by a higher commander.

d. Planning. Before a commander makes the decision to employ mines for local security, careful consideration must be given to his future plans, the local situation, the mine training of his unit, the availability of mines, and the avoidance of friendly casualties due to the use of mines. He must plan when and where mines will be employed, the types of mines to be used, and coordination with other plans.

(1) When employed. A security mine field may be used when a unit halts to consolidate its position and to reorganize prior to resuming the attack; when on the defensive or on an independent or isolated mission such as a detached post, outpost, working party, or defense of a road block; or when it is a reserve, supporting, or administrative unit behind the front lines or in a reserve area.

(2) Where employed. A security mine field may be laid by small units for all-around protection or for protection to front, flanks or rear, to cover likely avenues of enemy tank or foot-troop approach. All mines must be covered by small arms fire. They must be located beyond hand grenade range and so that adequate warning of enemy approach is given to listening posts and observation posts in time to alert all members of the unit.

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(3) Types of mines. Antipersonnel mines, as well as antitank mines, may be used for security mine fields. Mines may be buried or concealed above ground; however, they must be placed so that they are readily removable by the unit installing them. This precludes the use of specialized types of mines, fuses, and devices in a security mine field. All mines planned for use in a security mine field must be readily detectable by a standard mine detector. Trip flares may be installed and noise devices may be devised and used to give warning of enemy approach during periods of poor visibility.

(4) Coordination and control. A commander of any unit planning installation of a security mine field must be well-informed of future plans and constantly aware of the local situation. Fullest coordination with commanders of outposts, friendly patrols, adjacent units, and all other units likely to enter the area is of the greatest importance to avoid friendly casualties. It is essential to plan and insure that approaches into a security mine field are clearly defined or guarded. Warning must be given to all friendly personnel, including outposts, patrols, and withdrawing security forces, of the location of the mine field or groups of mines and of the safe lanes through or around them. The next higher commander and other interested units must be immediately informed of any planned installation of a security mine field so that its installation can be co-ordinated with future plans. Timely information of future attack, defense, or withdrawal plans; demolitions plans; and other mine field plans must be transmitted to units installing security mine fields to afford time to remove installed mines or adjust plans accordingly.

e. Execution of plans. Any unit commander who installs a security mine field is responsible for its protection by fire, for guarding it against friendly casualties, and for full-coordination with friendly units likely to enter the area where the mine field is located. He will be held directly responsible for laying, marking, recording, reporting, and removal of the mine field.

(1) Installation. To avoid being surprised by the enemy during installation of a security mine field, the responsible unit commander will insure that the location of the field is adequately protected and covered by fire. He will insure that adequate lanes through or around the mine field are left for the use of patrols and covering forces and for friendly troops entering and leaving the position. It is not mandatory that mines be installed according to set patterns in a security mine field; however, it is essential that all mines be accurately located on the ground for future removal. Any unit commander installing a security mine field is directly responsible for its removal after it has served its purpose or before leaving the position, unless a relieving unit commander assumes such responsibility by signing a written report to that effect.

(2) Marking. Security mine fields will be marked in conformance with the standard marking method prescribed by paragraph 47 to prevent

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casualties to friendly troops. When approved mine-marking equipment is not available or cannot be brought up in time, field expedients will be utilized to avoid friendly casualties.

(3) Recording. Careful notation of all mines will be made by the commander of each unit installing a security mine field. Several individuals must be fully cognizant of the exact locations of mines on the ground and the type of firing devices being used for each, so that they can remove the mines should those who installed them become casualties.

(4) Reporting. A report of the location of security mine fields will be made in accordance with paragraphs 46 and 48 by the installing unit commander to the next higher commander. This report will include an overlay or sketch of the mine field. Each echelon receiving such reports will consolidate and forward them to the next higher commander, up to the division level.

(5) Removal.

(a) All mines, both antitank and antipersonnel, used in security mine fields will be removed by the installing unit either prior to departure from the area or when the mines have served their purpose, unless a relieving unit commander specifically requests them to be left in place.

(b) A removal report consisting of a revised location report will be prepared and forwarded to the next higher commander by the unit removing the mines. These reports will be consolidated and forwarded by each echelon up to the division level.

(c) In cases where it has been specifically requested that the mines be left in place, actual location of all mines will be pointed out on the ground to the relieving unit by the units being relieved and records will be turned over to the relieving unit commander. A written message to this effect will be prepared and signed by both commanders and sent to the next higher commander of both the relieved and relieving commanders. These reports will be consolidated and transmitted by each echelon in turn to the next higher commander up to the division level.

18. DEFENSIVE MINE FIELD

a. Purpose. A defensive mine field is usually installed for the purpose of improving the obstacle plan in front of or on the flanks of a battalion, regimental, or division sector or zone in order to delay, disorganize, and canalize enemy attack formations or to protect the flanks from enemy counterattacks.

b. Characteristics. A defensive mine field is characterized by one or more antitank or antipersonnel mine belts laid across the front or flanks

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of a unit, tied in to other artificial as well as natural obstacles, and protected by small-arms fire and the fires of organic and supporting weapons.

f. Authority to install. Battalion or higher commanders have authority to install defensive mine fields unless such authority is reserved or revoked by the next higher commander. Immediately after making a decision to install a defensive mine field, the commander will notify the next higher commander by the most expeditious means available and consistent with security. This information will be transmitted by each echelon to the next higher echelon up to and including army level.

g. Planning. Every authorized commander who makes the decision to install a defensive mine field is responsible for insuring that the plan for installation is fully integrated and coordinated with all other local plans.

(1) When employed. Defensive mine fields may be employed when a unit is on the defensive to assist in the prevention of enemy penetration, or when its attack has been halted to protect against enemy counter attack. They are usually laid out of range of enemy ground observation and fire and before security echelons have been withdrawn. They may, however, be laid while in contact with the enemy but then only at night or during periods of poor visibility and under cover of defensive fires.

(2) Where employed. Defensive mine fields are sited to cover likely avenues of infantry or tank approach and where they can be fully covered by small-arms fire and fires of direct and indirect-fire weapons. They may be installed in one or more mine belts, in front of or in rear of the final protective barrages of the main line of resistance, where they are covered by the final protective fires of the battle position. They may be located on the flanks of the battle position or on the flanks of an attacking unit to afford protection from enemy development or counterattack. They are sometimes used in rear positions of a defensive sector to add depth to the battle position and to protect against likely penetrations as well as infiltration, guerrilla, and airborne attacks. They may also be installed on the beaches of rivers, lakes, and the ocean and augmented with antiamphibious mine belts to repel enemy river or lake crossings and amphibious landings. Wherever laid, defensive mine fields are usually buried or covered and camouflaged. They will be laid in accordance with standard patterns prescribed by paragraph 38 b. Scattered laying of mines in a defensive mine field is prohibited, except in the area within 100 yards forward of the most forward belt of a defensive mine field.

(3) Types of mines. All types of antitank and antipersonnel mines, including nondetectable mines and mines using varied types of fuses

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may be employed in a defensive mine field. Antipersonnel mines may be superimposed upon antitank mine belts or installed in separate anti-personnel mine belts forward of, in rear of, or between antitank mine belts. Use of special purpose mines with nondetectable, and antilift devices must be carefully weighed against hazards to friendly troops and planned future operations. Higher commanders must place restrictive limitations on the use of special types of mines if future plans are likely to be affected. Warning devices such as trip flares, smoke streamers, and noise devices should be used in defensive mine fields to warn of breaching attempts by the enemy.

(4) Coordination and control.

(a) Defensive mine fields must be carefully coordinated and integrated with the fire-support plan, the antitank defense plan, and the counterattack plans of local reserves. As part of the barrier plan, they must be tied in closely with demolition plans and with other artificial and available natural obstacles to cover likely enemy approaches into a position. Close coordination between adjacent units and dissemination of information to all echelons is essential to avoid friendly casualties. Information of attack, defense, or withdrawal plans; demolition plans; and other barrier plans must be disseminated early enough so that units responsible for protection, installation, or breaching of the defensive mine field can make adequate plans and preparations well in advance of impending operations.

(b) Higher commanders must place restrictions on the issue or employment of special types of mines and fuses if their use is likely to affect future operations or cause friendly casualties. Commanders of all units authorizing or installing defensive mine fields must make certain that adequate lanes are left and coordination is effected with security echelons, patrols, and reserve forces to permit them to fully accomplish their missions. Closing of such lanes must be as carefully planned and coordinated as the demolition of critical bridges in retrograde operations.

(c) Continuing and unremitting surveillance of defensive mine fields through the aid of warning devices, listening and observation posts, aerial observation, and active patrolling must be planned. This is essential to provide timely intelligence of enemy breaching operations and to permit defensive preparation against impending attacks by the enemy. Such information, properly evaluated and disseminated, assists materially in avoiding surprise attacks by the enemy.

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e. Execution of plans.

(1) Installation. Any commander with authority to lay a defensive mine field may delegate responsibility for actual installation of the mine field to any subordinate unit commander organically assigned, supporting, or attached to his command. Where possible, the responsibility, control, and supervision should be delegated to commanders of engineer units augmented or assisted by other combat, supporting, or administrative troops, units.

(2) Protection. Each unit commander installing a defensive mine field is responsible for its protection by small arms and other weapons unless otherwise directed. Upon completion of the installation, protection of the defensive mine field comes automatically under the control of the combat unit commander in whose sector the mine field or portion thereof is located. If the mine field is on the flank or rear and outside of the boundaries of a front-line combat unit, responsibility for its protection will be delegated by the commander who authorized the installation.

(3) Marking. All defensive mine fields and the safe lanes through them will be adequately marked in conformance with the standard marking method prescribed by paragraph 47. Marking fences and signs forward of a mine field or belt may be removed after security forces have been withdrawn.

(4) Recording and Reporting. The commander responsible for installing a defensive mine field or any portion thereof is responsible for the proper recording and reporting in accordance with the procedures prescribed in paragraphs 46-48. As a minimum, location and lane records and reports will be prepared and submitted. Copies of the reports are forwarded to the commander authorizing installation of the mine field. The commander authorizing the installation consolidates the reports and forwards them to the regimental, division, corps, and army headquarters. The commander authorizing the installation of a defensive mine field is responsible for its records and their distribution. The commander who installs the mine field is responsible for marking the field. Sufficient local records are kept by the installing unit to permit hasty breaching, change of safe lanes, and transfer of information to a relieving unit. The relieving and the relieved unit commanders will both sign copies of a statement to the effect that the records have been transferred to and accepted by the relieving unit commander. Signed copies of the statement will be forwarded to the next higher commanders of both the relieving and the relieved unit commanders.

. 19. BARRIER MINE FIELD

a. Purpose. A barrier mine field is employed to delay, disorganize, disrupt, and canalize large-scale enemy attacks and to require

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the enemy to concentrate his forces in areas covered by massed defensive fires, including atomic weapons and guided missiles, where maximum casualties may be inflicted upon him before and during his attack.

D. Characteristics. A barrier mine field is characterized by its maximum resistance to breaching or passage by the enemy. It may consist of numerous mine belts emplaced laterally and axially to the front to canalize the enemy in his approaches to the position and to cover the wide intervals between defensive strong points or centers of resistance. It includes large-scale mine fields laid on the flanks of large units to protect them against wide enemy envelopment or counterattacks. Mine belts are anchored to other major artificial and natural obstacles to complete the overall barrier plan of a large unit or units.

c. Types of barrier mine fields. Barrier mine fields are classified as tactical and strategic.

(1) Tactical barrier mine fields may be employed in great depth and density to cover the wide intervals between strong points on a wide-front defense. This use canalizes and delays the enemy and provides time for the defender to concentrate fires in the wide intervals between strong points and to move mobile reserves to repel an enemy offensive. It may deter the enemy from attempting an attack through the intervals and around the flanks of strong points and force him to choose a frontal attack against well-defended strong points.

(2) Strategic barrier mine fields are barrier mine fields of such magnitude that they have strategic significance. They may be planned in advance as strategic barrier mine fields to cover the front or flanks of large units in great depth, or they may be derived from a combination of tactical barrier mine fields employed by a number of units which become so extensive that they are of strategic importance and thus are termed strategic barrier mine fields.

d. Authority to install.

(1) Division and higher commanders have authority to install tactical barrier mine fields unless such authority is reserved or revoked by a higher commander.

(2) Only a theater or higher commander has authority to authorize a strategic barrier mine field.

e. Planning.

(1) General. Every authorized commander who makes the decision to install a barrier mine field is responsible for insuring that the plan for installation is fully integrated and coordinated with all other

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plans. A barrier mine field requires great military foresight in planning. If planned to afford maximum delay to the enemy, it will also present maximum difficulties to the commander who authorized its installation should he find that he must breach his own mine field to attack or pursue the enemy. A barrier mine field may also present the commander who orders its installation with political, economic, and psychological factors which must be carefully weighed and considered before he makes the decision.

(2) When employed. Barrier mine fields may be planned and installed prior to the outbreak of hostilities, when it appears that war is imminent and that a prolonged defense is necessary at the outset of the war. If installed prior to the outbreak of hostilities, barrier mine fields can usually be prepared secure from enemy air observation and fire as well as secure from enemy ground observation and fire. They are, however, subject to enemy espionage and possible sabotage. If installed after hostilities begin, they may be prepared in areas protected temporarily from enemy ground observation and fire, but it may not be possible to protect them from enemy air observation and fire.

(3) Coordination and control. Barrier mine fields must be sited carefully in conformity with fire support plans. They must be anchored to other artificial as well as natural obstacles to complete a continuous barrier plan or one which will canalize the enemy into the most lucrative concentration areas covered by massed fires of the defender's supporting weapons. Barrier mine fields may be laid on the flanks and in rear of large units in the attack to protect against counterattack by highly mobile enemy reserves, or in the defense to protect against airborne, ground, or amphibious enveloping attacks. Highly mobile reserves must be available to cover these fields by fire when the need arises. All barrier mine field plans must be carefully integrated with future offensive plans, counterattack plans, withdrawal plans, and other mine field, barrier, obstacle, and demolition plans. Lanes must be left for the withdrawal of security forces and provision made to fully coordinate closing the lanes immediately after withdrawing troops have cleared each belt. Continuous surveillance by all units of those portions of the barrier mine field in their sector is of paramount importance. Plans must include use of special warning devices, and the detailed observation of critical routes of enemy approach through the use of active patrols, listening and observation posts, and aerial observation. Prompt reporting by all defensive agencies of enemy activity and breaching operations in the barrier mine field affords the higher commander timely intelligence for use in evaluating any imminent large-scale offensive by the enemy.

(4) Types of mines and special employment. Various types of antipersonnel and antitank mines and fuses may be used in a barrier mine field including nondetectable mines. Special types of fuses, and devices

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add to the difficulties of enemy breaching operations. However, extensive use of special types of mines, fuses, and devices may increase the requirement for trained specialists beyond installing unit capacities. Anti-personnel mines may be superimposed upon antitank mine belts or installed in separate antipersonnel mine belts forward of, in rear of, or between antitank mine belts. Standard or nonstandard patterns may be employed in all mine belts. Scattered antipersonnel and antitank mines may also be sown within or between mine belts. Such use confuses the enemy and delays removal of mines as well as increases the possibility of inflicting heavy casualties and provides a psychological deterrent to enemy breaching parties. If the enemy is successful in breaching one or more belts, timely intelligence might enable the commander to relay the breached sections with anti-personnel or antitank mines by the use of patrols, aircraft, or other suitable means at his disposal. If the enemy succeeds in launching an attack after breaching a mine field, aircraft or other suitable means might be used to resow or vastly increase the density of mines in the zone of enemy attack. This will tend to delay or demoralize the attacking forces and prevent him from reinforcing assault echelons with supporting and reserve units. All such plans for the use of special types of mines and special employment of mines must be carefully weighed with planned future operations requiring the eventual use of mined areas to avoid casualties to friendly troops. Higher commanders must place restrictive limitations on the use of special types of mines and on indiscriminate or random sowing of scattered mines if future operations are likely to be affected adversely.

f. Execution of plan.

(1) Installation. Responsibility for planning and laying a barrier mine field may be delegated to any unit or units by the commander authorized to order the installation of such a mine field. Normally the commander ordering the barrier mine field will have the overall plan prepared in his headquarters. Units charged with the responsibility for installing the mine field or portions thereof will coordinate their efforts to the fullest extent to insure conformity with the overall plan. Responsibility for the actual laying of a barrier mine field may be assigned to any unit or units using troops and indigenous labor. The organization of all troop units and labor engaged in laying a barrier mine field will be coordinated and supervised under engineer control.

(2) Protection. Each unit commander engaged in installing a portion of a barrier mine field is responsible for its protection, unless otherwise directed. Upon completion of the installation, protection comes automatically under the control of the combat unit commander in whose sector that portion is located. If the mine field is on a flank or in rear of and outside of the boundaries of a front-line combat unit, its protection will be directed by the commander who authorized the installation.

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(3) Marking. Each barrier mine field and each safe lane through it will be adequately marked in conformance with the standard marking methods prescribed in paragraph 47. Marking fences and signs forward of a mine field or mine belt may be removed after security forces have been withdrawn.

(4) Recording and reporting. Commanders of units responsible for installing portions of a barrier mine field are responsible for the proper recording and reporting in accordance with the procedure prescribed by paragraphs 4664d. As a minimum, location and lane records and reports will be prepared and submitted. Copies of the reports are forwarded to the commander authorizing the installation of the mine field. The commander authorizing the installation of a barrier mine field is responsible for its records and their distribution. Enough local records are kept by the installing units to permit changing safe lanes and to facilitate transfer of information to a relieving unit. The relieving and the relieved unit commanders will both sign copies of a statement to the effect that the records have been turned over to and accepted by the relieving unit commander. Signed copies of the statement will be forwarded to the next higher commanders of both the relieving and relieved unit commanders.

20. INTERDICTORY MINE FIELDS

a. Purpose. An interdictory mine field provides a means of hindering or preventing enemy use of an area or route.

b. Description. An interdictory mine field may consist of few or many mines of standard and improvised types. These mine fields may be used by large or small units in either a strategic or tactical role. They are not normally covered by ground fire.

c. Authority to install. Army commanders and higher are authorized to order the installation of interdictory mine fields. This authority may be delegated or revoked as considered necessary.

d. Planning. In planning interdictory mine fields, the primary consideration must be given to the future plans of friendly forces. Inherent in the plan must be either an assumption or the knowledge that friendly forces will not be required to operate in the area to be mined within a specified period of time. If it is not intended to use the area in the near future, planning need give little consideration to the ability to neutralize friendly interdictory mine fields. Planning the installation of interdictory mine fields designed to aid a tactical operation must be initiated at the command level directing the operation. Like other types of mine fields, the interdictory mine field will be included in the barrier plan of the command. Planning for mining operations with strategic significance will be initiated at theater level. However, the detailed planning

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and execution of these operations will be a responsibility of subordinate units.

(1) When employed. Interdictory mine fields are employed tactically to harass the enemy's support elements as well as his combat troops. These mine fields may be profitably employed in the conduct of a retrograde movement, a position defense, a counterattack, and other basic tactical situations. When employed strategically, interdictory mine fields prevent enemy utilization of very important facilities which may fall into his hands or which are already in his hands. This employment of mine fields will frequently arise from the denial policy of a theater commander or higher. Such a policy may also permit the execution of a "scorched earth" or a more limited type of denial operation. It is in the conduct of a limited denial operation that mine fields have their most widespread strategic application; however, they may also be employed in the conduct of a strategic evacuation and strategic bombardment.

(2) Where employed. In general, interdictory mine fields are sited in areas and across routes which the enemy will be most likely to use. Specific operations employing interdictory mine fields include:

(a) Retrograde movement. During or just prior to the conduct of a retrograde movement, the interdictory mine fields may be installed across enemy avenues of approach and within certain important areas. When so emplaced they render these areas temporarily untenable, deny access to the areas, and restrict movement in any direction through the areas. Suitable locations for installation are roads and trails, bivouac areas, water points, command posts, and similar positions likely to be occupied by the enemy.

(b) Position defense. While occupying a defensive position, interdictory mine fields may be emplaced in rear of the enemy's positions. Such a use is analogous to the employment of artillery for interdiction. The sites for these installations will be similar to those selected during a retrograde movement. Intelligence may make the selection of enemy occupied sites possible. Aerially emplaced mines will normally be the most effective. However, the possibility of using patrols, guerrillas, and partisans to emplace mines to the enemy rear must not be overlooked.

(c) Counterattack. Assistance in the execution of a counterattack designed to restore our lines can be rendered by the use of interdictory mine fields. These mine fields will be installed in the vicinity of the base of an enemy's penetration and outside of the area which our troops plan to reoccupy. Such use of mines will assist in preventing enemy movement of reinforcements and supplies into the penetration at the most critical stage of his offensive. Emplacement of the mines by air or other means will be necessary.

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(d) Denial operation. The installation of interdictory mine fields is an important adjunct to the execution of a strategic limited-denial operation. Such an operation has the function of preventing enemy utilization of important facilities by removal, destruction, or denial. The effectiveness of the partial destruction of important installations such as petroleum tank farms, railroad terminals, hydroelectric plants, timber stockpiles, major bridges, and airfields will be greatly enhanced by interdictory mine fields. The emplacement of these fields may occur well in advance of a projected withdrawal if the facilities are not in use. In any case, considerable time will be required for their effective emplacement.

(e) Evacuation. Prior to the forced or voluntary evacuation of an area as the result of tactical or strategic considerations, interdictory mine fields may be installed for the sole purpose of creating a nuisance to future occupants of the area. Booby traps and dirty-trick devices will find widespread application in this instance.

(f). Deep aerial emplacement. Aerially emplaced interdictory mine fields can be employed to supplement strategic bombing. Conventional bombs and atomic bombs rely upon complete destruction to accomplish the mission of preventing the enemy from supporting his combat forces. Political, economic, psychological, and practical considerations may make it desirable to minimize the damage inflicted upon enemy facilities. In this event, the saturation of strategic industrial complexes and residential communities with aerially emplaced mines may effectively retard production without causing extensive damage.

(3) Types of mines. Interdictory mine fields may be expected to restrict the movement of enemy motor vehicles, locomotives, boats, and airplanes as well as personnel. Hence, these mine fields may contain antitank, antirail, antimarine, antiairborne, and antipersonnel mines. All types of conventional and nonconventional mines and firing devices, dirty-trick devices, and booby traps should be used to the maximum extent consistent with the purpose of the field and the time and material available. In the event future plans contemplate a return to the mined area within a specific time period, the mine field may contain special features which may render it ineffective prior to the time of return to the area. The effectiveness of interdictory mine fields will be largely determined by the ingenuity of the troops installing the field.

(4) Coordination and control. Interdictory mine fields require high-level coordination and integration with future plans. Tactical employment of interdictory mine fields must be considered as a part of the operation plan and must be coordinated with the elements thereof. If the employment of an interdictory mine field will be of strategic significance, consideration must be given to the political and economic policies of the theater of operations. Particularly important is the coordination with

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the air commander when mines are to be aerially emplaced close behind the enemy rear. The ground commander must have final approval of target selection in this instance. Control of aerial mining may be effected by the designation of a "no-mine line" or "no-mine area" which serves the same purpose as the conventional bomb line.

e. Execution of Plans.

(1) Installation. Any commander with authority to lay an interdictory mine field may delegate responsibility for actual installation of the mine field to any subordinate unit commander organically assigned, supporting, or attached to his command. Where possible, the responsibility, control and supervision should be delegated to commanders of engineer units augmented or assisted by other combat, supporting, or administrative troop units. Interdictory mine fields may be laid to pattern in the interest of speed. However, scattered or random laying is preferable because of the added difficulty of removal by the enemy. Security, defensive, barrier, and deceptive mine fields are considered interdictory mine fields after they have fallen into enemy hands.

(2) Protection. Coverage by fire is not a prerequisite of an interdictory mine field. On the other hand, such fields installed in the course of a retrograde movement should be covered by fire for as long as the range of available weapons permits. Upon completion of the installation, protection and maintenance of the interdictory mine field comes under the control of the commander in whose sector the mine field is located for as long as it can be covered adequately by fire.

(3) Marking. Marking of an interdictory mine field is not required unless it will endanger the safety of our own troops prior to the time that it is expected to fall into enemy hands. The commander ordering the installation of the field will specify the extent of marking to be used. When marking is required, standard markings as prescribed by paragraph 47 will be used. Markings may be removed after withdrawal of security forces.

(4) Recording and reporting. The commander ordering installation of an interdictory mine field is responsible for proper recording and reporting of the mine field. The commander physically installing the mine field is responsible for preparing the required records and reports except that aerially emplaced mine fields will be recorded and reported by the installing Air Force commanders to the concurring ground commander. A location record and report will be prepared for each interdictory mine field. A detailed record may be required at the discretion of the commander ordering the installation. A copy of each record will be retained by the commander making the installation. The commander authorizing or ordering

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the installation of an interdictory mine field is responsible for consolidation of records and their distribution to each higher and lower echelon.

21. DECEPTIVE MINE FIELD

a. Purpose. A deceptive mine field is used to perform the functions of security, defense, barrier, and interdictory mine fields or to provide lanes through those fields.

b. Description. A deceptive mine field is a simulated mine field. It may contain some live mines or it may contain only dummy or simulated mines.

c. Authority to install. Deceptive mine fields may be authorized and installed by any commander.

d. Planning. The effectiveness of a deceptive mine field depends upon its degree of resemblance to a live mine field.

(1) When employed. Deceptive mine fields are employed when time, effort, or material do not permit installation of normal mine fields or when it is desired to camouflage a lane through a mine field.

(2) Where employed. Deceptive mine fields will normally be used in conjunction with larger mine fields; that is, they will supplement or extend live fields and will seldom be used alone. They frequently serve as lanes in existing mine fields. Deceptive fields may also be considered as temporary expedients to be replaced as soon as the factors which required their installation become invalid.

(3) Types of mines. Both antitank, antipersonnel, and other types of mines may be emplaced, in a deceptive mine field. Dummy mines or scrap metal may actually be emplaced, or the earth may simply be disturbed at the point where a mine would have been placed.

(4) Coordination and control. The same degree of coordination and control will be required for a deceptive mine field as is required for the conventional mine field which it is designed to simulate.

(5) Marking, recording, and reporting. Standard marking, recording, and reporting procedures required for the mine field which is being simulated will be used.

(6) Protection. Deceptive mine fields should be covered by fire to be most effective; however, they can only be given the fire coverage accorded the type of mine field which they simulate. Deceptive mine fields used as part of a barrier or interdictory mine field will frequently not be covered by fire.

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22. DEFENSE OF MINE FIELDS

a. Plans must be made to cover all mine fields, except interdictory mine fields, with direct or indirect-fire weapons. Mine fields which cannot be protected by fire are susceptible to rapid breaching and clearance by the enemy and must be considered interdictory mine fields.

b. Outposts or listening posts may be placed in front of or in rear of a mine field or in a mine field itself to prevent enemy patrols from discovering the location of its forward edges, determining the direction and extent of the mine belts, and removing portions of the field. They may also be used to give timely warning of enemy breaching operations and to adjust mortar or artillery fire on enemy breaching parties when their own fire is inadequate to disperse the enemy.

c. The cellular nature of mine field installation tends to guide enemy attacks into pockets surrounded by mine fields. This delays the enemy, who can then be destroyed by heavy concentrations of artillery and mortar fire followed by a counterattack launched through concealed lanes in the mine fields.

23. DEVELOPMENT OF MINE FIELDS

In most situations, defensive operations are forced on a unit by a stronger enemy force. Rarely are defensive operations planned and executed without the presence of the enemy and without his interference unless accomplished prior to the opening of hostilities.

a. When an attacking unit has been slowed down or halted, it is unlikely that the duration of the defense will be known. During the initial organization of the ground, the unit places security mine fields which cover likely avenues of enemy approach. These mines are placed hastily, and may or may not conform to a pattern.

b. If the defense is prolonged, the unit may request that additional mine fields be installed, or it may be ordered to install additional mine fields for protection. The installation of defensive mine fields which are laid in standard pattern, may be supervised by unit engineers to insure that the fields are properly installed, marked, and recorded.

c. When the defense is to be further prolonged, a barrier mine field plan coordinated with an organized defense is formulated and issued from division or higher levels. Existing mine fields, including reported enemy fields, are utilized as much as possible in this plan. The existing mine fields, plus additional fields installed to complete the overall defense plan may become barrier mine fields.

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Section III. GENERAL CONSIDERATIONS

24. SITING OF MINE FIELDS

a. General. In determining the siting of mine fields in a given situation, the commander must first give consideration to his mission and planned future operations. Among other factors which he must consider are the number and type of mines available to him, the troops available for mine laying, and conduct of the operation, and the obstacle value of the terrain within the area. Thorough reconnaissance is essential to the effective employment of mines.

b. Basic principles.

(1) Coordination. Coordination is necessary between the organization installing the field and the unit responsible for guarding and protecting it. During installation, the mine field should be sited in terrain that can be covered effectively by protective small-arms, mortar, artillery, and antitank-gun fire.

(2) Utilization of terrain. Effectiveness of a mine field is increased by laying it on terrain which the enemy either cannot observe or has difficulty in observing. Mine field frontage is reduced to the minimum by making maximum use of natural obstacles and by restricting the mine field to terrain which can be covered effectively by defensive fire. To be effective, the mine field must be anchored to natural or other artificial obstacles to prevent the field from being outflanked, or it must be sited so that bypassing the field would result in more work or be more hazardous than breaching the field.

25. MINE FIELD LAYING

Individual mines may be emplaced in a definite geometric pattern or they may be laid without regard to the location of other individual mines. Both pattern laying and nonpattern laying have distinct advantages:

a. The advantages of pattern laying are:

- (1) Increases efficiency and speed of installation.
- (2) Insures thorough coverage with uniform density.
- (3) Exposes the minimum number of personnel at one time.
- (4) Makes recording of the field easier.
- (5) Facilitates location and clearing of the field.

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(6) Facilitates training of personnel.

(7) Increases adaptability to mechanical mine laying.

b. The advantages of nonpattern laying are:

(1) Increases the difficulty of breaching and clearance by the enemy.

(2) Increases flexibility, in that the density and depth can be more readily adapted to the character of the terrain.

c. The function of the field will determine the method to be employed in laying the field. Standard mine field patterns are described in paragraph 38b. All personnel must be trained in laying these patterns.

26. ANTITANK MINES

Antitank mines are the most common type employed in land mine warfare. They are employed when the enemy has the capability of attacking friendly positions with track or wheeled vehicles. All combat troops must be capable of installing all types of antitank mines. Security, defensive, barrier, interdictory, and deceptive mine fields will normally include antitank mines.

27. ANTIPERSONNEL MINES

Antipersonnel mines may be installed in conjunction with other types of mines, or they may be the only types of mines in a field. Since antipersonnel mines are extremely dangerous to friendly personnel, commanders should specifically authorize or restrict their use in all types of mine fields. Installing specialized antipersonnel mines and activated mines using specialized devices and fuzes is highly specialized work and must be performed by highly trained troops. Antipersonnel mines may be employed in the following specific ways:

(1) Singly or in fields in front of battle positions.

(2) Placed in woods, gallies, and defiles to provide warning of enemy approach.

(3) Placed in areas or in buildings or facilities to deny enemy use thereof.

(4) Attached to artificial obstacles and other mines to inflict casualties upon the enemy who attempts to clear or breach them.

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(5) Set as booby traps so arranged that any disturbance of a seemingly harmless object sets them off.

28. ANTIAMPHIBIOUS MINES

Antiamphibious mines are laid below the high-water line for the purpose of destroying enemy landing craft and personnel. They are installed under water along ocean beaches, river banks, and lake shores. Anti-amphibious mines are laid in conjunction with conventional antitank and antipersonnel mine belts which are installed on the beach or banks above the high-water mark, and with naval mines installed in the deep-water approaches. Antiamphibious mine belts may be part of security, defensive, barrier, interdictory, and deceptive mine fields.

29. ANTIAIRBORNE MINES

Antiairborne mines are employed to prevent the safe landing of enemy aircraft and parachutists. They are installed as part of an overall defense against enemy airborne operation. They may be standard or improvised mines of all types as well as specially developed antiairborne mines. Security, defensive, barrier, and deceptive mine fields may be used for defense against airborne attack.

30. MARKING OF MINE FIELDS

To prevent casualties to friendly troops, all mine fields, including deceptive mine fields and enemy mine fields that have been overrun by friendly troops or incorporated in our defense positions, must be marked in a manner known to all personnel. Precautions must be taken to prevent troops from entering mine fields being installed and marked. Interdictory mine fields may or may not be marked.

a. Responsibility.

(1) Marking. Troops laying the mine field are responsible for marking the field as it is installed.

(2) Maintenance. Sectors of responsibility for maintenance of marking fences are specified by the commander of the area in which the mine field is situated.

b. Marking of lanes and gaps. Lanes and gaps must be provided to permit passage of vehicles and troops through mine fields. The method prescribed in paragraph 47 for marking safe lanes through mine fields is also used for marking gaps breached through enemy mine fields. When a mine field is breached on a road, standard mine-road-clearance signs are used to mark safe lanes.

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g. Withdrawal. During a withdrawal, the lanes through mine fields must be closed as soon as all personnel have passed. The defense plan must be clearly understood by the unit responsible for closing the lanes. Sufficient warning must be given the unit responsible for closing lanes so the work can be done quickly and effectively.

d. Lanes through rear-area mine fields. Vehicle lanes through rear-area mine fields may be located along roads and trails to prevent obvious curves or deviations which would indicate a mine field or other obstacle. Also measures are taken to prevent forming a network of tracks converging at the entrance to the lanes. Lanes must be conspicuously marked and warning signs used plentifully. The standard lane-marking method is used.

31. RECORDING AND REPORTING

Mine field records are prepared and reports are rendered for the primary purpose of informing tactical commanders of the location of obstacles which may effect tactical operations. Those records and reports serve a secondary purpose of facilitating the subsequent removal of the mines by friendly forces. The location of planned mine fields is reported prior to starting laying. During the installation of large mine fields, progress reports are submitted. Upon completion, final location and lane reports are submitted as a minimum.

a. Overlays and maps. Division, corps, and army engineers keep special situation(barrier) maps on which all essential information concerning friendly and enemy mine fields is graphically entered. This information is used to keep commanders, unit staffs, and troops in the mine areas accurately informed. Division, corps, and army engineers distribute overlays, to appropriate scales of 1:1,000,000 to 1:25,000 of special situation(barrier)maps periodically. It is important, therefore, that newly installed mine fields be recorded and records be forwarded to the proper headquarters immediately.

b. Alterations. Any changes made in a field are recorded, and the reports forwarded to interested headquarters. For example, records of changes made in a defensive mine field are sent to headquarters of division, corps, and army; records of changes made in a security mine field are forwarded to headquarters of battalion, regiment, and division.

c. Transfer of responsibility. Whenever one unit relieves another, the unit commander of the relieving unit automatically assumes all the mine field responsibilities formerly assigned to the commander of the relieved unit, unless otherwise directed by higher commander. The commander of the relieved unit furnishes the commander of the relieving unit all records and information concerning friendly and enemy mine fields in the area. He

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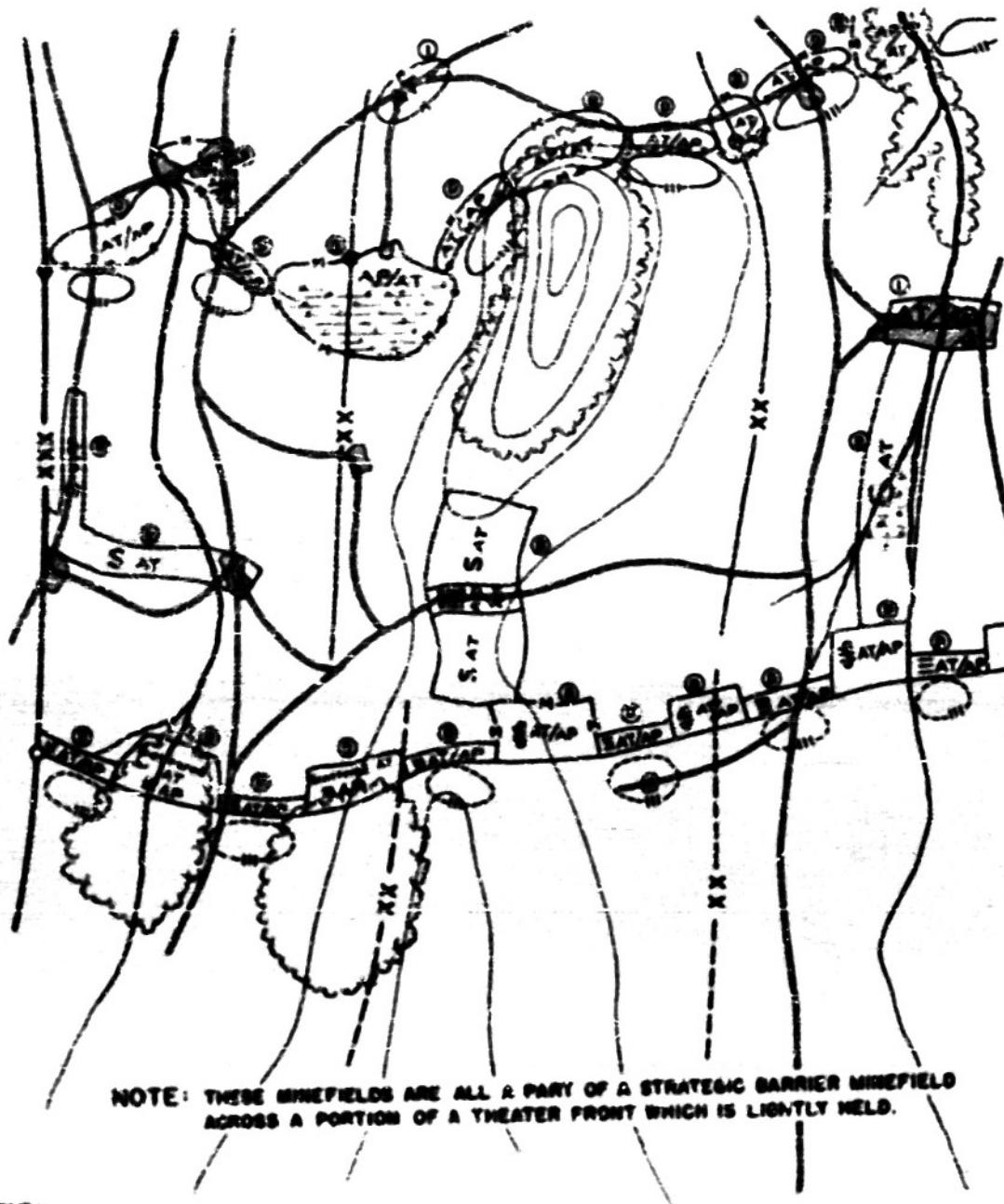
also supplies the necessary ground-reconnaissance personnel to insure correlation of all mine field information. All higher commanders are responsible for insuring that a proper transfer of information is effected.

32. MINE BREACHING AND CLEARING

a. The planning and the conduct of an attack across a large enemy mine field closely parallels that required in the attack of a river line. Breaching the initial gape is performed by infantry troops with engineer assistance just as in an assault river crossing. As enemy fire is removed from the mine field and the bridgehead enlarged on the far side, special troops and equipment enlarge the gape for passage of tanks and vehicles. Only those areas needed in the initial assault and support of the assault are cleared.

b. After the assault forces have driven beyond the mine field and have successively established a new line, the rear echelon troops clear the mines from those areas which are required for immediate use. Further mine clearance is carried out by rear echelon troops as needed. Civilian labor may be employed for mine clearance of areas for civilian use. This is usually done under military supervision.

c. Techniques of breaching and clearing mine fields are given in paragraph 60.



LEGEND:

(1) INTERDICTION

(2) BARRIER

(3) DEFENSIVE

PLANNED MINEFIELD
SCATTERED MINES

PLANNED FIELD, SCATTERED MINES
SUPERIMPOSED IN THREE BELT FIELD

Figure 1.

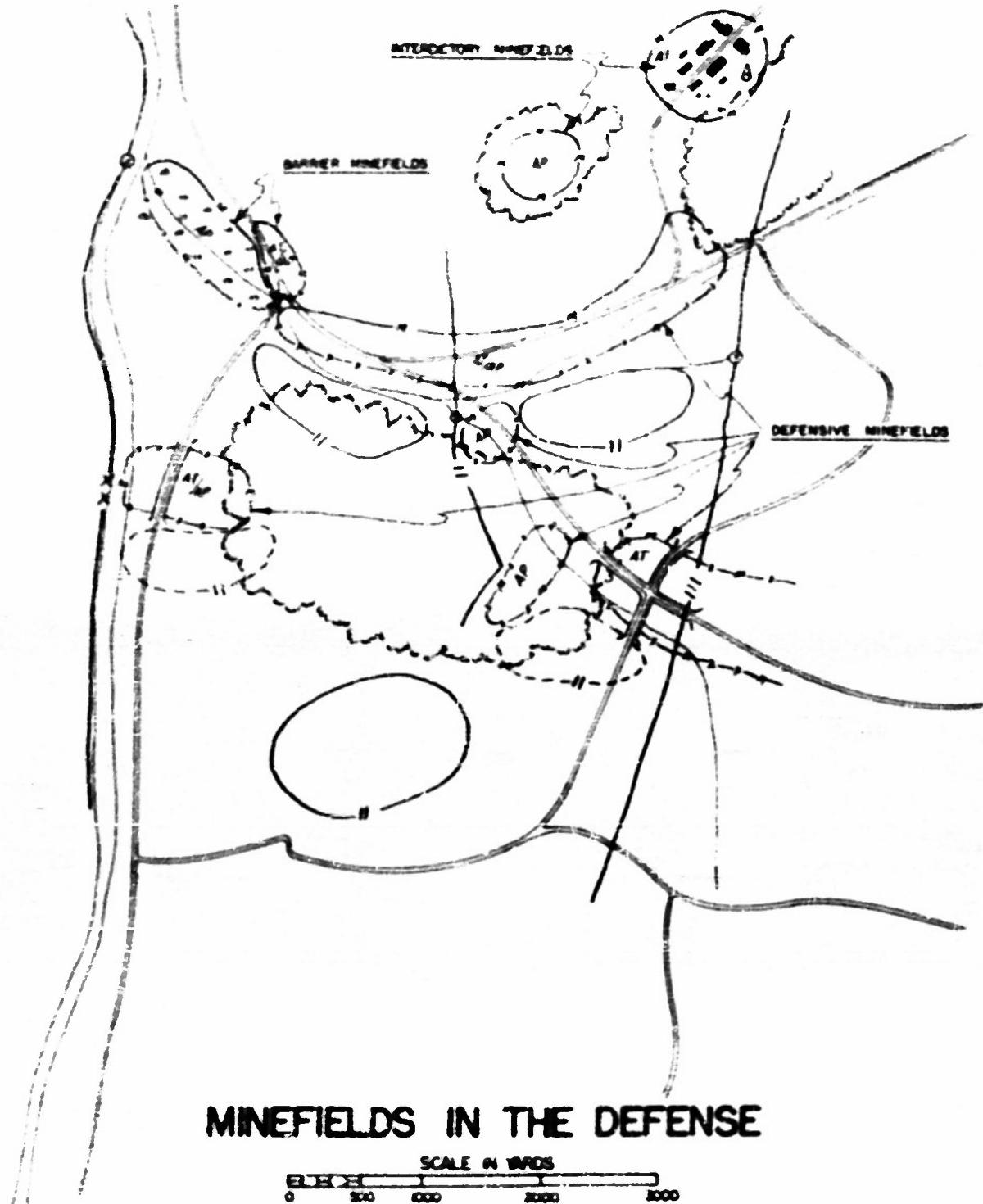


Figure 2.

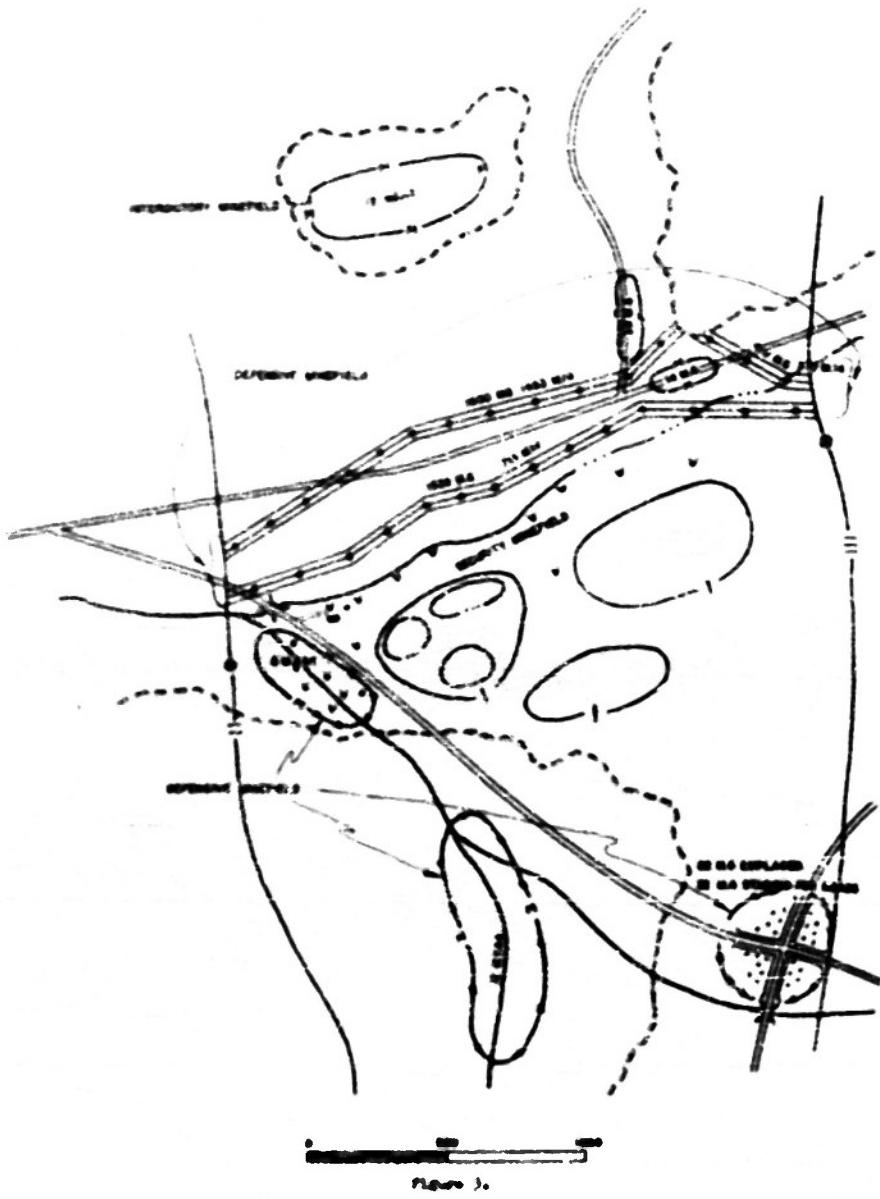


Figure 3.

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INCLOSURE 2
APPENDIX C
RECOMMENDED CHANGES TO FM 101-10

Recommend that present paragraph 80, FM 101-10, Staff Officers' Field Manual- Organization, Technical, and Logistical data be deleted, and the following substituted therefor:

80. MINE FIELDS

CLASSIFICATION	INSTALLATION	EXPLANATION	AUTHORITY	RECORDING	QUANTITIES AND RATE
Defensive	Installed for the purpose of improving the defensive plan in front or on the flanks of a battalion, regiment, or division sector or zone in order to delay, disorganize, and annihilize enemy attack formations placed in rear or to protect the positions of flanks from enemy a defensive counterattack.	Employed to assist in the prevention of enemy penetration when on the defensive. When an attack has been halted to protect against enemy counterattack.	Division, regiment, and battalion commanders have authority to install defensive mine fields unless such authority is reserved or revoked by the next higher commander.	The commander responsible for installing a defensive mine field or any portion thereof is responsible for the proper recording, reporting and marking of the mine field.	1000 mines per 1000 yard mine bolt (1 mine per yard of bolt)

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CLASSIFICATION	INSTALLATION	EMPLOYMENT	AUTHORITY	RECORDING	QUANTITIES AND RATE
DEFENSIVE (Cont.)	as infiltration, guerrilla, and airborne attacks.	May also be employed along beaches to repel enemy river or lake crossings and amphibious landings.	May become part of a barrier line during extended static operations.	1 aqued. 30 mines per hour. 1 man, 4 mines per hour.	Uncasing at forward supply point: 1500 mines per platoon-hour (M2-A and M3) 7000 mines per platoon-hour (M4)

Above figures are average. Quantities and rate of installation will vary depending upon type of soil and types of mines and fuses used.

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CLASSIFICATION	INSTALLATION	DEPLOYMENT	AUTHORITY	RECORDING QTY	QUANTITIES AND PAGE
Security	Installed in front or around a defense position of a small unit for protection against enemy infiltration and surprise night attacks.	Employed across avenues of likely approach when on the defensive or in independent or isolated positions.	Any unit commander may be instructed to protect the installation unless such an attack has been halted.	A general location record is required. This record will include an overlay or sketch of the mine field.	Same as defensive type field.

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CLASSIFICATION	INSTALLATION	APLICMENT	AUTHORITY	RELEASING	QUANTITIES	AMMUNITIONS
SUR. ACT	Tactical:	PRACTICAL:	Tactical and Strategic:	PRACTICAL:	Tactical and Strategic:	
	Employed to cover wide intervals between higher command posts.	Division or higher command posts.	Commanders of units controlling portions of the mine field are responsible for reporting, recording, and marking.	Strategic:	Strategic:	
	Installed in accordance with divisional or higher command posts coordinated to the commander ordering the installation who is responsible for their distribution.	Higher command posts.	Copies of records are forwarded to the commander ordering the installation who is responsible for their distribution.			

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CLASSIFICATION	INSTALLATION	DEPLOYMENT	AUTHORITY	RECORDING	QUANTITIES AND RATE
					No set quantities but rate roughly the same as security field if laid by hand.
Interdictory	Installed in accordance with army or higher commands and along routes which the enemy will be stalled.	Army or higher command authorizes installation.	Authority may specify marking as required. Marking may be removed after withdrawal of security forces.	Marking is not necessarily required. If so, the safety of friendly troops is unhampered prior to withdrawal, the installing authority may specify marking as required. Marking may be removed after withdrawal of security forces.	Marking is not necessarily required. If so, the safety of friendly troops is unhampered prior to withdrawal, the installing authority may specify marking as required. Marking may be removed after withdrawal of security forces.
	Cannot normally be covered by supporting forces, ground fire.	To prevent use or revocation of very temporary fast-ordnance which fall into enemy hands or which are in his hands.	Usually installed during or prior to the conduct of a retrograde movement.	A location record is required. Detailed records may be required at the discretion of the commander ordering the installation.	A location record is required. Detailed records may be required at the discretion of the commander ordering the installation.
		Any be employed in the conduct of a strategic or operational strategic bergerment.	Can be installed on any lines by aerial replacement, patrols, Guerrillas, and partisans.	Records will be distributed to army, army group, corps, theater commanders, when appropriate, and to subordinate commanders in whose areas the field is located.	Use of booby traps dirty-trick devices and delay explosive charges encouraged.

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CLASSIFICATION	INSTALLATION	EMPLOYEE AUTHORITY RECORDING	UNITS
DECEPTIVE	Installed to supplement or extend lines and when time, effort, or a test is do not permit installation of other type wire fields.	Since as type one field will be used. All standards have the authority to employ a deceptive technique to frequently employed to obtain information in live wire or fiber optics or to provide easily bypassed lines for future operations.	Standard working procedures for on-the-job field which is standard by the security service. Rules for installing units in security micro field.

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INCLOSURE #3

AUTHORITY FOR MINE LAYING

The United States position may be summarized as follows:

a. Mines are an integral part of our military means. The commander should be given the latitude to use mines in such a manner as to lend the maximum of effectiveness to the overall system. He should be restricted only when his free use of mines may impose undue restriction on the operational plans of the higher commander. If mine use must be restricted it should be done by positive statement of the higher commander. Thus, the company commander is permitted the use of simple, readily detectable mines for his local security; the battalion or regimental commander is permitted the use of more complex mine fields around his defensive position and in the local areas between the positions of the smaller units; the division commander is permitted the use of the most complex mine types to cover those areas of his defense not protected by troop dispositions. The full development of any of these mine usages, if likely to interfere with the planned operations of the higher commander, must be controlled by positive restriction.

b. Four functional classifications of the uses of mine fields are recognized. These and their primary identifying characteristics are:

(1) Security mine fields used for close-in protection and warning to small units in the battle position, in a rear area, or on an isolated mission. Mines used in this field must be simple and readily detectable to permit ready removal. Company or higher commanders may authorize this mine field.

(2) Defensive mine fields are used around defensive positions or to protect the flanks in an attack, within range of small arms to analyze the enemy and delay him under the fires of the defender's weapons. This field will owe its effect primarily to the weapons of the defender. Battalion or higher commanders may authorize this mine field.

(3) Barrier mine fields are used in the gaps between the defensive dispositions in larger unit defenses and may or may not be covered by fire. Since this field must delay the enemy until reserves can be brought into position, it is characterized by the maximum difficulty of breaching and great diversity of mine types to enable the mines themselves to afford the field protection. Division or higher commanders may authorize this mine field.

(4) Interdictory mine fields are used in the enemy's rear to harass him or to deny him use of local areas. This classification

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includes friendly mine fields which have been overrun, nuisance mining, booby traps, and other such mine usages. It may include aerially emplaced mines or mines of any type.

c. Any of the functionally classified mine fields may contain antiamphibious, antiairborne, antitank, antipersonnel, or antivehicle mines as appropriate.

d. The ground commander must have the authority to restrict the use of aerially emplaced mines as necessary to prevent undue hindrance to his planned operation.

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INCLOSURE 4 TO APPENDIX A, PART ONE

GLOSSARY

Aerial Emplacement-	Aerial emplacement is the act of installing, laying, or sowing mines from aircraft.
Antilift Device- (Activate)	An antilift device is a device arranged to explode the mine to which it is attached, or to explode another mine or charge nearby, if the mine is moved.
Arming-	Arming is the preparation of a fuzed mine for operation.
Barrier-	A barrier is a series of related obstacles across an expected avenue of enemy approach.
Barrier Plan-	A barrier plan is a plan for a barrier system. It is designed to supplement the tactical plan.
Barrier System-	A barrier system is a series in depth of related barriers.
Booby Trap-	A booby trap is an explosive charge, either a standard mine or an improvised charge, which is exploded when an unsuspecting person disturbs an apparently harmless object.
Breaching-(Gapping)-	Breaching is the employment of any available means to secure a gap through an enemy mine field or unfamiliar friendly mine field.
Danger Area-	The danger area is that area outside the effective casualty radius within which personnel may become casualties from fragments.
Density, Area-	The area density of a mine field is the average number of mines per square yard of area.
Density, Mine Belt-	Mine belt density is the number of mines per yard of trace.
Density, Mine Field-	Mine field density is the summation of effective densities in a mine field.
Detector, Mine-	A mine detector is a device capable of reliable location of specific mine types. Detectors usually have a specific application and very definite limitations.

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Detector-Eradicator-	A detector-eradicator is a single device which combines the functions of a detector and eradicator. (See eradicator).
Dirty-trick Device-	A dirty-trick device is a manufactured booby trap such as an explosive-filled flashlight, fountain pen, pencil, or other such article which explodes when an attempt is made to put article into normal use. Rifle cartridges filled with a high explosive, or a hand grenade with an instantaneous fuze are also examples of dirty-trick devices.
Effective Casualty Radius-	The effective casualty radius is that distance within which 50 percent of all personnel become casualties upon detonation of a mine.
Eradicator-	An eradicator is a device designed for rapid breaching or clearing of mine fields. Examples of this device are the snake, flail, plow, roller, and jet-clearing device.
Floating Mine Net- (Boon)	A floating mine net or boom is a device suspended from cables or floats located upstream of river-crossing operations to stop or explode floating mines.
Fuze-	A fuze is a device for initiating the detonating action of a mine.
Fuze, Anti- disturbance-	An antidisturbance fuze is one which functions when moved or disturbed.
Fuze, Blastproof-	A blastproof fuze is one which cannot be initiated by blast pressure.
Fuze, Chemical-	A chemical fuze is one which functions when a chemical ampule is broken and the chemical comes into contact with the explosives.
Fuze, Electrical-	An electrical fuze is one which functions when an electrical circuit is closed and fires a detonating cap.
Fuze, Influence-	An influence fuze is one which is actuated by the properties of and the proximity to the target rather than by physical contact or pressure.

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Fuze, Mechanical-	A mechanical fuze is one which is fired by a mechanically released striker.
Fuzing-	Fuzing is the act of inserting a fuze assembly into a mine.
Marker, Auxiliary-	An auxiliary marker is an improvised marker such as a buried gas can or a pile of stones used as a mine field reference point when a suitable topographical marker is too distant from the mine field for accurate reference. The auxiliary marker is usually referenced to the topographical marker and the corner of the mine field.
Marker, Topographical-	A topographical marker is a permanent terrain feature or installation that is easily recognized on the ground and on a map that is used as a reference point in locating a mine field.
Marking-	Marking is a means for delineating the general area of a mine field and the approaches and edges of a mine field lane or gap.
Mine-	A mine is an encased explosive or other material designed to destroy or damage vehicles, boats, or aircraft or designed to wound, kill, or otherwise incapacitate personnel. It may be detonated by the action of its victim, by the passage of time, or by controlled means.
Mine, Antiairborne-	An antiairborne mine is a mine designed to prevent or hinder airborne landings by damaging or destroying aircraft and its occupants and by killing or wounding parachute troops either while airborne or upon landing.
Mine, Anti- amphibious-	An anti-amphibious mine is a mine designed to destroy or disable amphibious vehicles, landing craft, or other boats during seaborne or inland-waterways operations.
Mine, Antipersonnel-	An antipersonnel mine is a mine designed to kill or disable personnel.
Mine, Antirailway-	An antirailway mine is a mine designed to destroy or damage roadbeds, locomotives, or other rolling stock.

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Mine, Antivehicular- An antivehicular mine is a mine designed to destroy or disable land vehicles other than tanks.

Mine, Armor-piercing- An armor-piercing mine is a mine so constructed that its blast effect, upon detonation, will be concentrated to perforate armor.

Mine, Blast- A blast mine is a mine which is dependent upon its blast effect to produce the desired results.

Mine, Chemical- A chemical mine is a mine containing a toxic gas, incendiary agent, or other chemical agents. Its purpose is to destroy or damage vehicles and kill or disable personnel through direct contact or chemical reaction produced upon contact with equipment or supplies.

Mine, Dummy- A dummy mine is an inert, simulated mine designed for deceptive mine fields. It may be made of any available material.

Mine, Fragmentation- A fragmentation mine is a mine which is constructed in such a manner that, upon detonation, it will project fragments and shrapnel.

Mine, General-Purpose- A general-purpose mine is a mine designed for employment against more than one type of target.

Mine, Improvised- An improvised mine is a mine which is made of any available materials. Improvised mines are used when standard mines are not available or are incapable of producing the desired results.

Mine, Practice- A practice mine is a replica of a standard mine. It has the same features and weight of the high-explosive mine. It is constructed to emit a puff of smoke or make a noise to simulate detonation.

Mine, Probeproof- A probeproof mine is a mine which is not easily detectable by probing.

Mine, River- A river mine is a mine designed to destroy floating bridges, fixed bridge piers, and ferrying equipment. They must be released upstream and floated toward enemy river-crossing operations or anchored in areas of possible enemy crossings.

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Mine, Tank-disabling-	A tank-disabling mine is a mine capable of causing sufficient damage to a tank to require second echelon maintenance.
Mine, Tank-killing-	A tank-killing mine is a mine capable of eliminating a tank from current operations by requiring base maintenance or replacement, and by causing casualties among the crew members.
Mine, Training-	A training mine is an inert replica of a standard mine used for instructional purposes.
Mine Belt-	A mine belt is an area containing mines laid to a pattern. A mine belt contains one or more mine sections and usually follows an irregular line.
Mine Clearing-	Mine clearing is the detection and removal of all mines within a mine field.
Mine Field-	A mine field is an area in which mines have been emplaced. It may contain mines or other explosives laid according to a pattern or without pattern.
Mine field, Anti-airborne-	An antiairborne mine field is a mine field installed primarily for protection against airborne attack.
Mine field, Anti-amphibious-	An anti-amphibious mine field is a mine field installed primarily for protection against amphibious attack.
Mine field, Anti-personnel-	An antipersonnel mine field is a mine field consisting primarily of antipersonnel mines.
Mine field, Antitank-	An antitank mine field is a mine field consisting primarily of antitank mines.
Mine field, Barrier-	A barrier mine field is a mine field of considerable magnitude installed to complete the overall defense plan of large units for a prolonged period.
Mine field, Deceptive-	A deceptive mine field is a simulated mine field used in place of other type live mine fields or in conjunction with them to economize on time, labor, and materials.

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Mine field, Defensive-	A defensive mine field is a mine field installed to improve the defensive positions of battalions, regiments, and divisions.
Mine field, Gap-	A mine field gap is a lane through a mine field resulting from a breaching operation.
Mine field, Interdictory-	An interdictory mine field is a mine field which hinders enemy use of an area or route. It cannot normally be protected by supporting ground fire.
Mine field, Lane-	A mine field lane is a passage through a friendly mine field. It can be clear of mines or it may contain mines equipped with remote control devices.
Mine Section-	A mine section is the basic element of a pattern mine field. It is that part of a mine belt which is laid without change in direction.
Mine field, Security-	A security mine field is a mine field which provides local protection for small units.
Mine field, Strategic-	A strategic mine field is one so located, or of such extent that its primary effect is of strategic significance. A strategic mine field is installed normally by direction of a theater or higher commander. A strategic mine field may include a number of smaller component fields, any one of which may be primarily of tactical interest.
Mine field, Tactical-	A tactical mine field is one in which the primary application or effect is of tactical significance. A tactical mine field is installed by authority of any commander.
Neutralization-	Neutralization is the act of rendering a mine ineffective, by destroying, removing, or disarming.
No-Mine Area-	A no-mine area is an area outside and beyond the no-mine line designated by ground forces within which aerial mines may not be emplaced without clearance from the ground forces.
No-Mine Line-	A no-mine line is a line designated by ground forces beyond the line of contact within which aerial mines may not be emplaced without clearance from the ground forces. This line is a

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precautionary measure to guard against accidental aerial mining of friendly ground forces. The mine line should be easily identifiable by terrain features from the air and the ground so as to prevent confusion.

Obstacle-

An obstacle is an artificial or natural obstruction that hinders, stops, or slows down an advance.

Pattern laying-

Pattern laying is the placing of individual mines in a fixed relationship to each other.

Planter-

A planter is a mechanically or hand-operated device capable of rapidly laying standard or specially developed antitank and antipersonnel mines.

Probing-

Probing is a method of detecting mines by penetrating the earth with a sharp instrument such as a bayonet or standard mine probe.

Resowing-

Resowing is the placing of mines by aerial or ground operations to close gaps in mine fields made by enemy penetrations.

Scattered laying-

Scattered laying is the placing of mines in a field without regards to pattern but to a specific density.

Self-destruction-

Self-destruction is a means of clearing a friendly mine field by the use of delay fuzes within the mines set for detonation at a predetermined time.

Suspect Area-

A suspect area is a locality which is believed to contain mines.

Sweeping-

Sweeping is the use of standard mine detectors for detection of mines.

Sympathetic Detonation- Sympathetic detonation is the detonation of one or more mines induced by the explosion of another.

Trace-

A trace of a mine belt is a real or imaginary line parallel to the longitudinal direction of the belt.

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INCLOSURE # 5

MINE DENSITY

FIELD DENSITY

The optimum density of a completed minefield is not subject to a fixed answer. Optimum density depends on support fires available, enemy capabilities, type of terrain, type of mine and fuze, and results desired. As discussed below a density of one mine per yard of belt trace is determined to be the minimum acceptable when using pressure actuated mines in belts covered by fire. This may be increased by additional belts as the situation demands and logistical capabilities permits.

BELT DENSITY

The density of a mine field is defined as the average number of mines per linear unit of length. Density has been generally accepted as the most important measure of effectiveness of mine fields. The concept of mine field density has never been limited by considerations of depth of field, nor of arrangements of mines within the field. Actually, both depth of field and arrangements of mines within the field are independently, of important theoretical as well as practical effect in determining minefield effectiveness. These effects are obvious upon logical examination and are susceptible of simple mathematical proof. The more important practical effects of arrangement of mines within a field have been previously discussed. These effects include those of the sympathetic detonation range of individual mines and ease of hostile breaching of the field. This particular discussion is primarily concerned with theoretical considerations. Three cases are believed representative of the range of conditions normally encountered in minefields; first, mines evenly spaced along a single row; secondly, mines evenly spaced along multiple rows; and lastly, mines distributed truly at random, or in such a manner that they may be considered to be individually and collectively positioned at random. For each of these three cases the effective firing width of an individual mine, the vulnerable width of the target vehicle and the density of the minefield will be assumed constant.

(1) Single Row Field. It is obvious that if mines are so closely spaced along a single row that the target vehicle cannot avoid encountering at least one mine in attempted passage, then mine initiation is certain and no probability analysis is required. However, to permit comparison among the three cases of mine arrangement the following mathematical interpretation is made:

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Let P_1 = probability of initiation of a mine by one vehicle.

f = vulnerable width of the target vehicle in yards. Variations of mine and/or vehicle characteristics may be considered in this value.

d = density of the minefield in terms of mines per linear yard of minefield.

Then, the probability of the initiation of a mine by a single vehicle in a single row field is $P_1 = fd$ (1) and is a certainty for values of $fd \approx 1$. Practically, a single linear row of mines is tactically worthless because of simultaneous sympathetic detonation of all other mines in the row upon actuation by a target of any mine, and also, because of extreme ease of hostile breaching operations.

(2) Multiple Row Field or Belt. The closest physical spacing of mines in a minefield which is possible within the limitations of sympathetic detonation range is that wherein mines within any individual row are spaced evenly at sympathetic detonation range and successive rows are offset or displaced laterally one half mine interval from adjacent rows, so that sympathetic detonation range is just exceeded between mines in adjacent rows. This arrangement is impractical because it would violate uniform density. The individual offsets of all the rows in a mine field must result in an approximately even spacing of individual mines when the locations of such mines are projected upon the linear trace of the field. The nearest practical approach to the extreme effectiveness of the single row field as regards attempted passage by a single vehicle is, therefore, the field in which proper offsets are observed with spacing between rows such that sympathetic detonation range is not violated. When these conditions obtain, and even though spacings of individual mine rows be indefinitely extended, the probability of initiation of a mine in the first mine row encountered by a single vehicle is $P_{11} = \frac{fd}{n}$ (2),

where notation is as in the preceding subparagraph and n , the number of rows in the minefield. Probability subscripts indicate the row to which the probability applies. In determining probability of initiation of a mine in the second row it is assumed either that the approach is approximately normal to the row, or that the distance between adjacent rows is so great with respect to terrain, vehicle driving characteristics, and mine laying inaccuracies that the direction of approach to each mine row is an independent event. The necessity for accepting one or the other of these assumptions is necessary because when mine rows are offset from adjacent rows the practical possibility arises of the vehicle straddling pressure type mines or passing between influence type mines in all rows. However, either of these assumptions

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is considered reasonable and wholly acceptable since conscious effort will be made to site minefields so that hostile approach will be generally perpendicular to the field, and even if approaches are not perpendicular to the field, three factors tend to increase probability of mine row effectiveness. First, practically all mine row offsets established by pacing are apt to vary rather than be strictly geometrical; secondly, the effective density of each individual mine row increases as the angle of approach deviates from the perpendicular; and finally, the approach in such a direction as to encounter greatly increased minefield effectiveness is equally as likely as the "straddle" approach. Therefore, the probability of initiation of a mine in the second row may be accepted as:

$$P_{i_2} = \left(1 - \frac{r^d}{n}\right) \left(\frac{r^d}{n}\right) \quad (3)$$

and in the last row:

$$P_{i_n} = \left(1 - \frac{r^d}{n}\right)^n - 1 \left(\frac{r^d}{n}\right) \quad (4)$$

and probability of initiation in the field as a whole is:

$$P_i = P_{i_1} + P_{i_2} + \dots + P_{i_n} \quad (5)$$

(3) Random Mine Fields. When the arrangement of mines within a minefield is such that the mines may be considered as being distributed individually and collectively at random, the Poisson law of probability applies. This law applies to determination of probability when the number of trials is large and the probability of the occurrence of the event for any one trial is extremely small, conditions which certainly obtain when a vehicle encounters a truly random mine field. Practically, such distribution would require very deep mine fields in order that target vehicle approach to any individual mine could be considered as an independent event. The impracticability of laying mines randomly in the field has been discussed however, pattern mine fields do not vary materially from those randomly placed. Aerially emplaced mines may approach such arrangements. Using previous notation and introducing: λ = total number of mines; W = width of field; k is the number of mine initiations; and e = natural logarithm base; the probability of the initiation of a single mine in a truly random minefield may be determined as follows: The Poisson law expressed in previous notation for the occurrence of k mine initiations within a random field is:

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$$P_{(k,i)} = \frac{\left(\frac{M_f}{W}\right)^k}{\frac{k!}{i!}} e^{-\frac{M_f}{W}} \quad (6)$$

Expressed for no mine initiations,

$$P_{(0,i)} = \frac{\left(\frac{M_f}{W}\right)^0}{\frac{0!}{i!}} e^{-\frac{M_f}{W}} = e^{-\frac{M_f}{W}} \quad (7)$$

Then

$$P_1 = 1 - e^{-\frac{M_f}{W}} = 1 - e^{-df} \quad \text{since } d = \frac{M_f}{W} \quad (8)$$

(4) Illustrative Problems

(a) Optimum Density Four Row Mine Field. What is the probability of initiation of a single pressure type mine by a JS III tank in a single passage of a four-row minefield laid at a density of 1 mine per yard of front?

$$f = 1.39 \text{ yards}$$

$$d = 1 \text{ mine per yard of front}$$

$$n = 4 \text{ rows of mines}$$

$$P_{11} = \frac{1.39 \times \frac{1}{4}}{4} = .35$$

$$P_{12} = \left(1 - \frac{1.39 \times \frac{1}{4}}{4}\right) \frac{1.39 \times \frac{1}{4}}{4} = .23$$

$$P_{13} = \left(1 - \frac{1.39 \times \frac{1}{4}}{4}\right)^2 \frac{1.39 \times \frac{1}{4}}{4} = .15$$

$$P_{14} = \left(1 - \frac{1.39 \times \frac{1}{4}}{4}\right)^3 \frac{1.39 \times \frac{1}{4}}{4} = .09$$

$$P_1 = P_{11} + P_{12} + P_{13} + P_{14} = .35 + .23 + .15 + .09 = .82$$

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(b) Optimum Density Random Mine Field. What is the probability of initiation of a single pressure type mine by a JS III tank in a single passage of a random mine field laid to a density of 1 mine per yard of front?

$$d = 1 \text{ mine per yard of front}$$

$$f = 1.39 \text{ yards}$$

$$P_{i_1} = 1 - e^{-df} = 1 - \frac{1}{e^{1.39 \times 1}} = 1 - .249 = .75$$

(c) High Density Six Row Mine Field. What is the probability of initiation of a single pressure type mine by a JS III tank in a single passage of a six-row mine field laid at a density of 3 mines per yard of front?

$$f = 1.39 \text{ yards}$$

$$d = 3 \text{ mines per yard of front}$$

$$n = 6 \text{ rows of mines}$$

$$P_{i_1} = \frac{1.39 \times 3}{6} = .695$$

$$P_{i_2} = (1 - .695) \times .695 = .212$$

$$P_{i_3} = (1 - .695)^2 \times .695 = .065$$

$$P_{i_4} = (1 - .695)^3 \times .695 = .019$$

$$P_{i_5} = (1 - .695)^4 \times .695 = .006$$

$$P_{i_6} = (1 - .695)^5 \times .695 = .002$$

$$P_i = P_{i_1} + P_{i_2} + P_{i_3} + P_{i_4} + P_{i_5} + P_{i_6} \approx .999$$

(d) High Density Random Mine Field. What is the probability of initiation of a single pressure type mine by a JS III tank in a single passage of a random mine field laid to a density of 3 mines per yard of front?

$$d = 3 \text{ mines per yard of front}$$

$$f = 1.39 \text{ yards}$$

$$P_1 = 1 - e^{-df} = 1 - e^{-4.17} = 1 - .015 = .985$$

(4) Discussion. The above computations show that, for practical purposes, the difference in probability of mine initiation between a mine belt laid at random and one laid in rows, both having the same density, is of no great importance, being, only slightly higher for the field laid in rows. Therefore, the theoretical gain of initiation probability which results from pattern laying is of minor importance, Fig. 1. The probability of a kill is the probability of killing the tank in the event of a mine initiation for mines which are not capable of striking a kill for every initiation. This consideration is of no importance for mines now available for issue, unless they are used in multiple or with explosive increments. It remains to estimate the optimum density for mine belts laid with present mines. This optimum density is that density for which an increase in density will not give an appreciable increase in P_1 . The density is plotted in Fig. 2 as abscissa against the function $P_1 = 1 - e^{-fd}$ for values of f based on the JS III tank. Comparative curves for the JS III, the T34/85 and M-6 tanks are shown in Fig. 3.

A comparison of the differences from Fig. 2 follows:

Table I
Increase in d

Front	f_c	P
0.0	0.5	0.50
0.5	1.0	0.25
1.0	1.5	0.13
1.5	2.0	0.06
2.0	2.5	0.03
2.5	3.0	0.02

For JS III tank

It is seen in Fig. 2 that for a density of 1, $P_1 = 0.75$ and an increase in density of one half mine per yard of front will produce an increase in probability of mine initiation of only 0.13, Table I. This 5% increase in logistical requirements for mines is not justified by the small increase in probability of mine initiation realized. For mechanical laying, or paced spacing in rows, a mine belt of more than four rows of M-6 or equivalent mines will produce a probability of mine initiation of at least 75% against the JS III when the density is 1 mine per yard of front. More refined methods of analysis are not justified because the densities will vary from the above in practice due to the decisions made in the field by the officers in charge of the work. The decisions as to the number of belts in the field will vary the density of the field by increments of 1 mine per yard of front. The consideration of the effect of a field commander's decision to add even one additional belt further supports the selection of a normal density of 1 mine per yard of front. Addition of an additional belt to a

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belt of density of 1 will provide an increase in probability of mine initiation of .19 whereas if the original belt had a density of 1.5 the increase in probability would amount to only .10, and the overall advantage of the doubled more dense belts would amount to only .05, an extremely small return to receive for approximately half again the effort when measured in terms of numbers of mines and the physical work of installation.

COMPARISON OF EFFECTIVENESS OF RANDOM AND FOUR ROW COMPUTATIONS

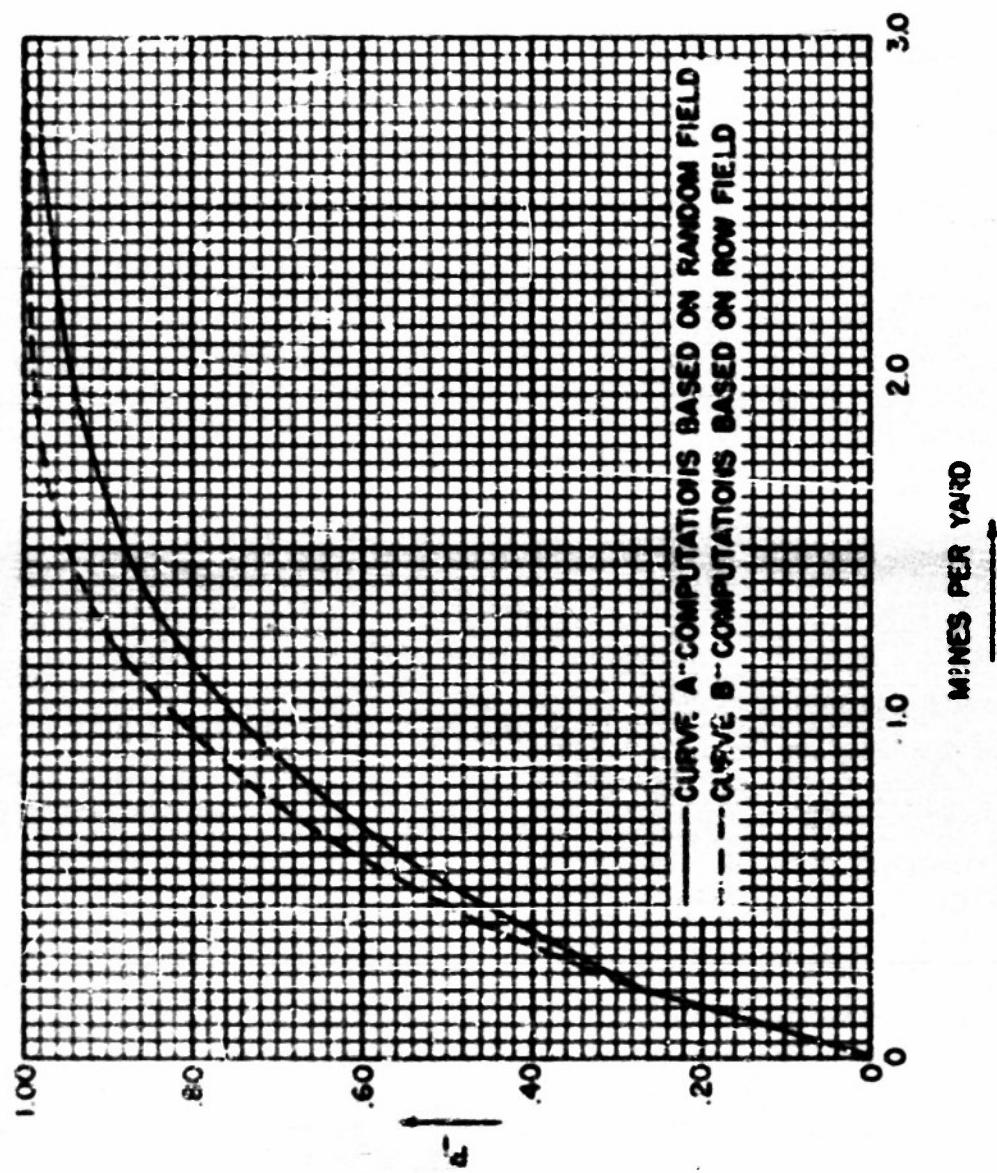


Figure 1.

EFFECT OF VARYING DENSITY ON
MINEFIELD EFFECTIVENESS

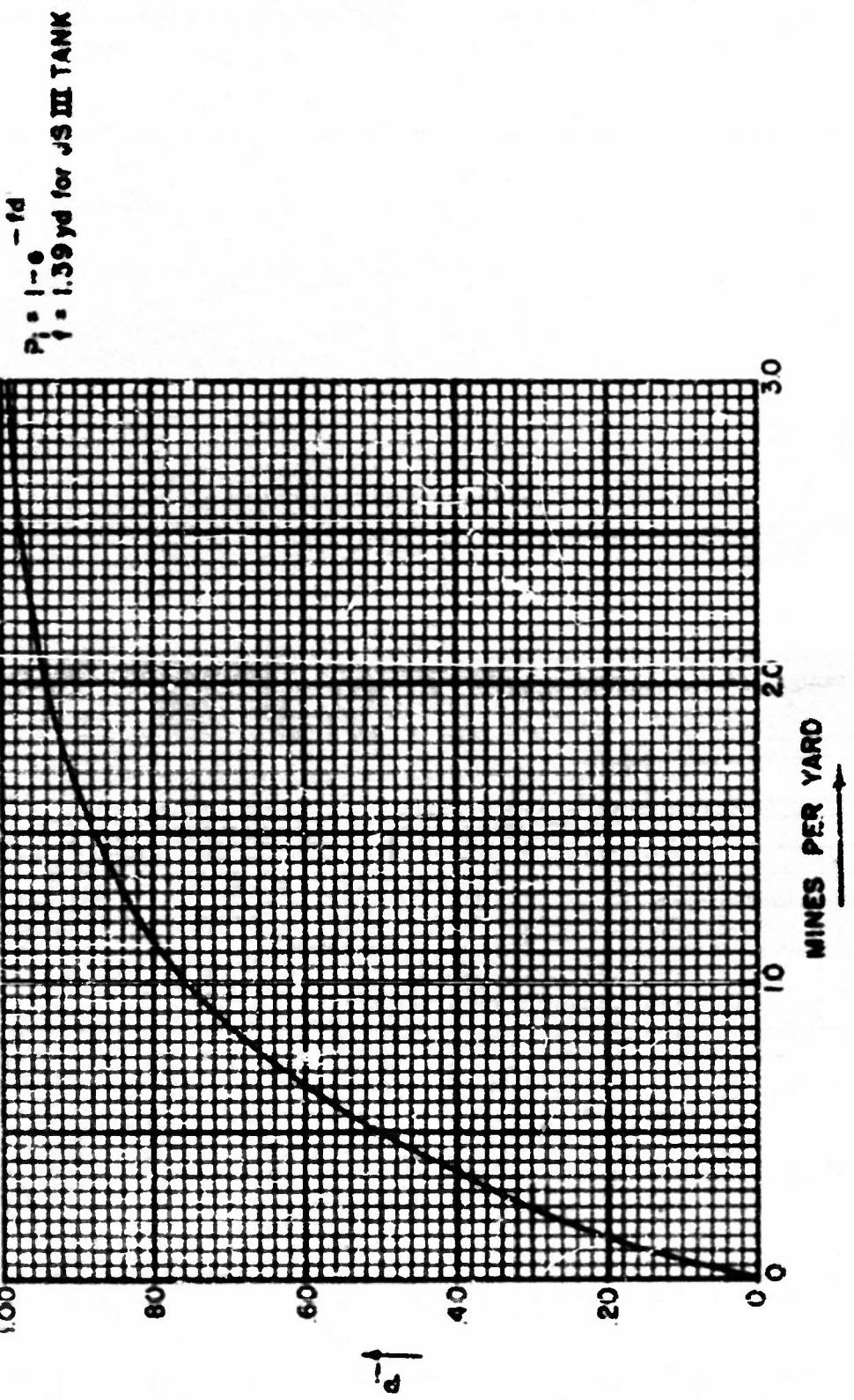


Figure 2.

EFFECT OF TANK CHARACTERISTICS ON
MINEFIELD EFFECTIVENESS

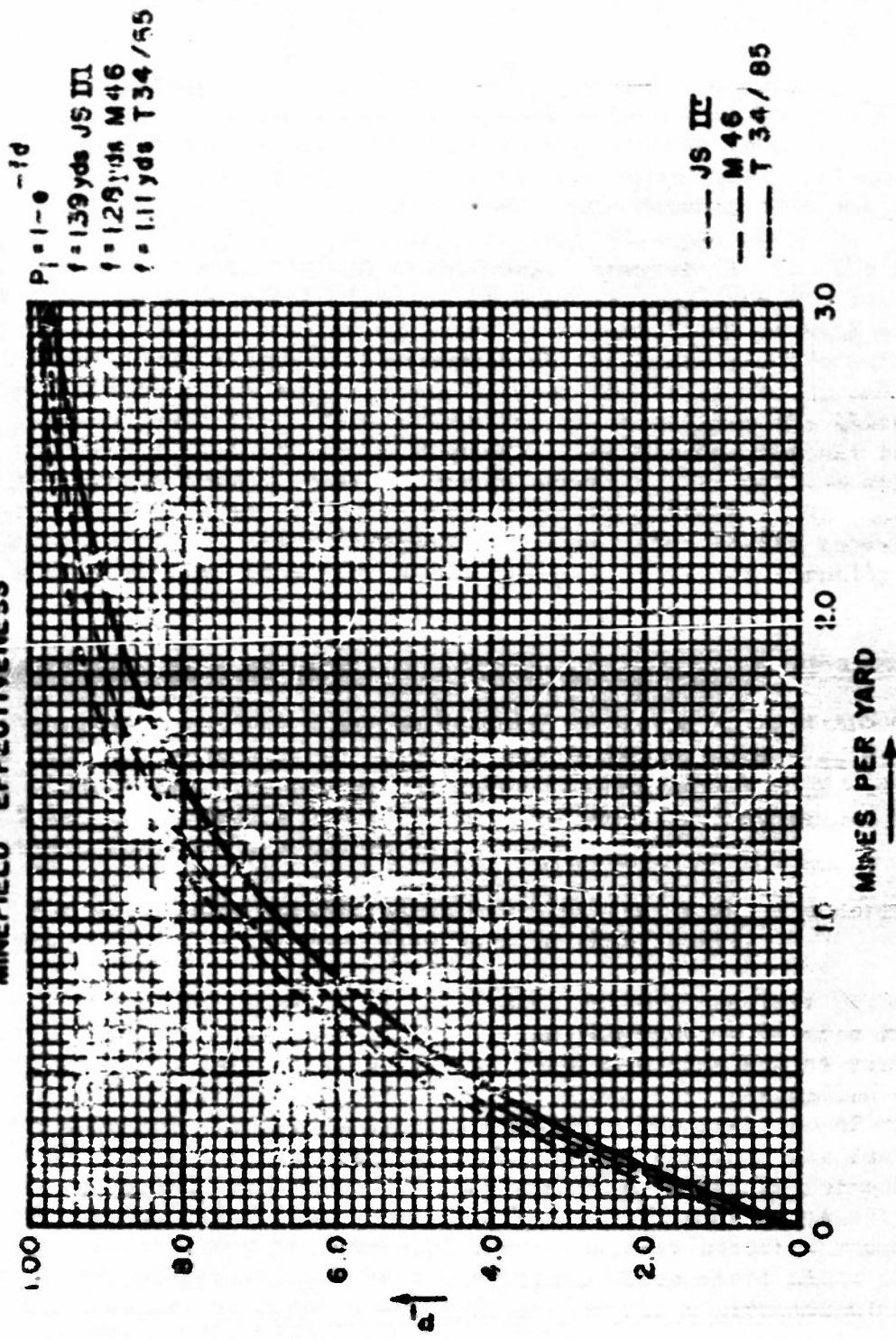


Figure 2.

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INCLOSURE # 6

MINE PATTERNS

1. Standard Antitank Patterns. Based on the minimum acceptable density of one mine per yard of front and the sympathetic detonation range for current pressure actuated mines of four yards, a basic four row pattern has been derived. Again based on the four yard sympathetic detonation range, a practical minimum spacing of four yards between rows was established. It was felt that a belt of this limited depth would be relatively simple to breach with assault techniques. However it was also recognized that the belt should be limited in depth to minimize the susceptibility of the belt to passage by tanks in column, each passing around as the one ahead was stopped. To compromise these two requirements the basic field was designed with 6 yards between the first and second row, 6 to 15 yards between the second and third, and 6 between the third and fourth, an overall depth of 18 to 27 yards. The minimum variant to this pattern is 4 yards between rows, 12 yards overall. The maximum variant is 15 yards between rows, 45 yards overall. This pattern is designed for use primarily where it can be covered with fire, due to its somewhat increased susceptibility to detection and passage it is not normally recommended for use not covered by fire.

2. Antipersonnel Mine Patterns.

(a) Antipersonnel mines may be used superimposed on antitank mine belts or used by themselves in belts either in conjunction with antitank belts or alone. Two patterns are provided for antipersonnel mines. These are the triangular pattern for trip wired antipersonnel mines and the pressure pattern for pressure activated antipersonnel mines.

(b) The triangular antipersonnel mine pattern is fully described in FM 5-32 and need not be further discussed in this report.

(c) The pressure activated antipersonnel pattern consists primarily of pressure type antipersonnel mines laid on the enemy side of a reference line along lines perpendicular to the reference line and at six foot intervals. One or more mines may be placed along each perpendicular line at various intervals to obtain desired density. The distance of the first mine from the reference line varies but is never less than six feet and usually not more than 30 feet. The same number of mines is normally placed along each perpendicular line to maintain a uniform section density but the density of a section may be increased where the belt passes through a more likely area for enemy attempts at penetration. Trip wired mines may be used as the furthest mine on every fourth or fifth perpendicular to aid in giving warning of penetration.

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3. Miscellaneous Considerations

a. Pattern Mining. Mine fields covered by small areas should be laid to a pattern in belts when the area to be mined is extensive. Pattern laying by drill is more efficient, gives greater economy, insures adequate coverage and proper density.

Standard patterns provide a means of uniform training and efficient field operations. The four row pattern for pressure action or antitank mines, and the triangular pattern and the pressure pattern for antipersonnel mines are standard. The antitank mine density of the four pattern is one mine per yard of mine belt trace.

b. Non-standard Pattern Mining. Under certain conditions patterns other than those which are standard should be used. The conditions which would affect a decision to lay to other than standard patterns are:

- (1) Shortage of mines.
- (2) Restricted areas (road blocks, defiles, villages).

The ingenuity of individuals and their knowledge of the terrain and the enemy's tactics should be used to devise patterns for use where it is deemed impossible to use the standard patterns.

c. Scattered Mining. Scattered mining is defined as the placement of individual mines without regard to the location of any other individual mine. The only exception is that one mine should not be laid within the sympathetic detonation range of another mine. This distance for mines containing up to 25 lbs of explosive is four yards.

Scattered mining should be used when areas not adequately covered by the fire are to be interdicted. Careful analysis of terrain for likely avenues of approach and alternate routes must be made for this method to be of real value. The average distance between mines is 4 yards; the maximum should rarely exceed 17 yards but may be greatly extended in route mining.

d. Route Mining. The most likely routes of approach for armored vehicles not under attack will be the roads. Retreating forces can extract high returns in damage and delay by using mines either scattered or in non-standard patterns on these routes. Concrete roads must be breached by explosives or mines placed by tunnelling in front the side. Thin bituminous or gravel roads may be scarified by road grates or sabots, check dams along the edges of road craters, and railroad crossings are located where mines may be installed without the aid of explosives or equipment.